Why Lighting Controls?

Considerations for the selection, installation, and commissioning of Lighting Controls

Why Lighting Controls?

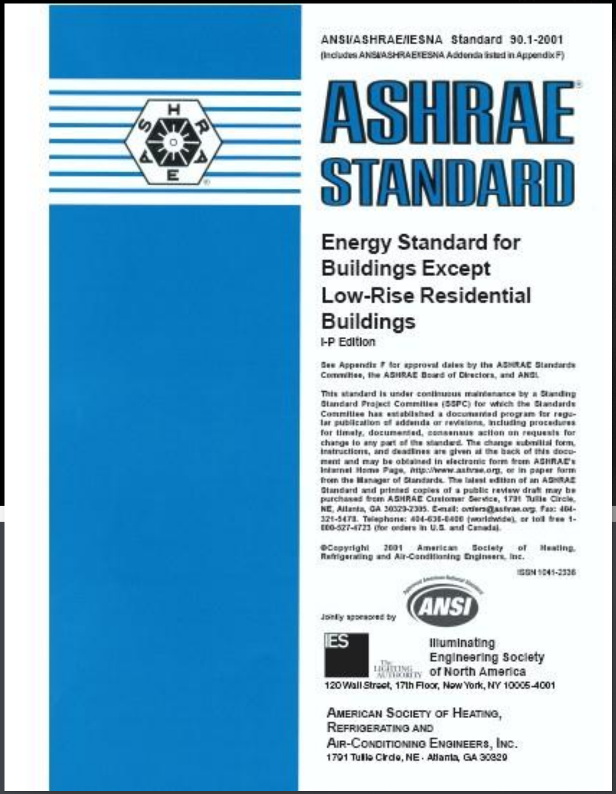
Lighting energy is <u>the</u> major electricity usage inside buildings today…

Buildings waste lighting energy…

35-40%

Why Lighting Controls?

Major trends driving the greater adoption of interior controls…



ANSI/ASHRAE/IESNA Standard 90.1-2001
(Includes ANSI/ASHRAE/IESNA Addenda listed in Appendix F)

ASHRAE STANDARD

Energy Standard for Buildings Except Low-Rise Residential Buildings

I-P Edition

See Appendix F for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and ANSI.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines are given at the back of this document and may be obtained in electronic form from ASHRAE's Internet Home Page, http://www.ashrae.org, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard and printed copies of a public review draft may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in U.S. and Canada).

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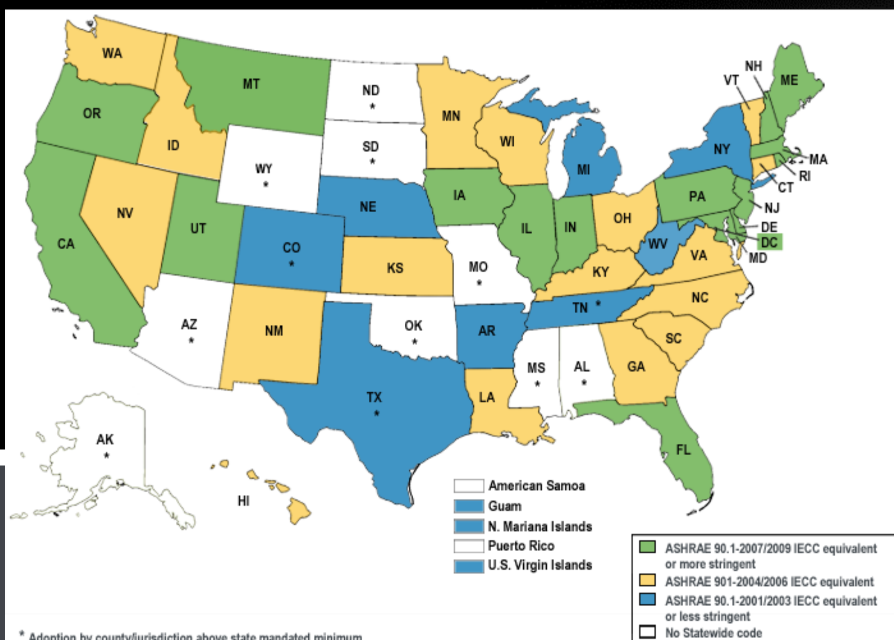
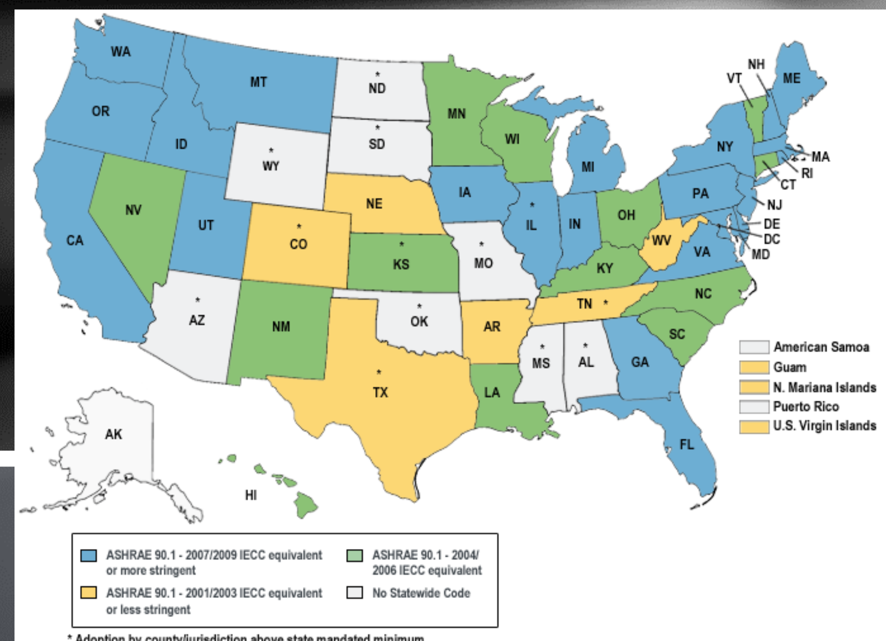
U.S. GREEN BUILDING COUNCIL
LEED
LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

Why Lighting Controls?

Energy Management & Sustainability… Standards & Codes



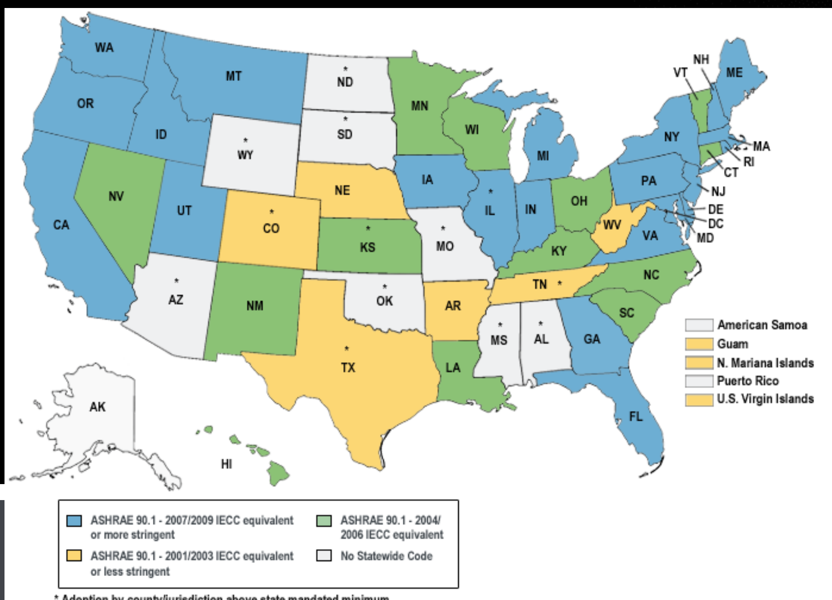
September 2010



March 2011

Why Lighting Controls?

General Lighting Controls Compliance



ASHRAE 90.1 (2007)
- Automatic shut-off
- Space control
- Exterior lighting control

IECC (2009)
- Automatic shut-off
- Space control
- Exterior lighting control
- Light level reduction control
- Daylight control zones

Utah's current energy code requires compliance with:
ASHRAE 90.1 2007
IECC 2009

Why Lighting Controls?

Two most common complaints & excuses:

- Lighting Controls are **too confusing**…

- Lighting Controls are **too expensive**…

Why Lighting Controls?

Agenda

- Lighting Control Strategies
- Lighting Control Topologies
- Sensor Selection and Placement
- Commissioning and System Tuning
- Where are we headed?
- Summary

Lighting Control Strategies

Manual Light Reduction

Overview

- Provides for the most basic form of energy savings in buildings
- Recommended for spaces where individual control of light increases occupant satisfaction and productivity
- Optimal for multiuse group spaces such as conference rooms and classrooms

Energy Savings

- 22% in private office
- 16% in open office
- 15% in retail environment
- 8% in classroom

Lighting Controls Effectiveness Assessment, ADM Associates, May 2002

Lighting Control Strategies

Manual Light Reduction Options

Switching

- Economical and effective way to save energy
- Minimal equipment required
- Easy to commission
- Ideal for spaces not occupied by critical tasks

Dimming

- Flexible and effective way to save energy
- Greater choice of light levels
- Can change lights without being intrusive
- Ideal for spaces occupied by critical tasks

Lighting Control Strategies

Scheduling

Overview

- Manages light status based on time of day
- Complies with commercial building energy codes requiring automatic shutoff
- Good for larger open spaces
- Spaces occupied most of the time
- Where lights cannot be turned OFF during normal operating hours without hurting safety or security

Energy Savings

- The most basic of automatic control strategies… energy savings varies by application and occupancy
- Scheduling capabilities essential for participations load shed energy management initiatives and demand response activities

Lighting Control Strategies

Scheduling Options

- Time-based control provided most frequently through astronomic timeclocks and intelligent relays
- Relays may use distributed or centralized topology
- Local wall controls and override switches provide enhanced control options and in many areas are required by code
- Participation in Demand Response initiatives requires central control of most building lighting

Lighting Control Strategies

Occupancy Sensing Overview

Turn off lights in an empty room

Vacancy sensors, manual on, make light use purposeful

Complies with commercial building energy codes requiring automatic shutoff

Ideal applications

- smaller, enclosed spaces
- spaces that operate on an unpredictable schedule
- spaces that are intermittently occupied

Lighting Control Strategies

Occupancy Sensing Options

Sensor technology

- passive infrared (PIR)
- ultrasonic
- acoustic
- dual technology

Mounting/enclosure

- wall
- ceiling
- high bay
- Indoor/outdoor

Power wiring

- line voltage
- low voltage

Lighting Control Strategies

Occupancy Sensing Energy Savings

Space Type	Lighting Energy Savings Demonstrated in Research or Estimated as Potential	Study Reference
Private Office	38%	*An Analysis of the Energy and Cost Savings Potential of Occupancy Sensors for Commercial Lighting Systems*, Lighting Research Center/EPA, August 2000.
Classroom	55%	
Restroom	42%	
Conference room	23%	
Break room	15%	
Open Office	15%	*Lighting Controls: Patterns for Design, R. A. Rundquist Associates*, Electric Power Research Institute, 1996.
Open Office (individual fixture control)	35%	Canada National Research Council study on integrated lighting controls in open office, 2007.

Lighting Control Strategies

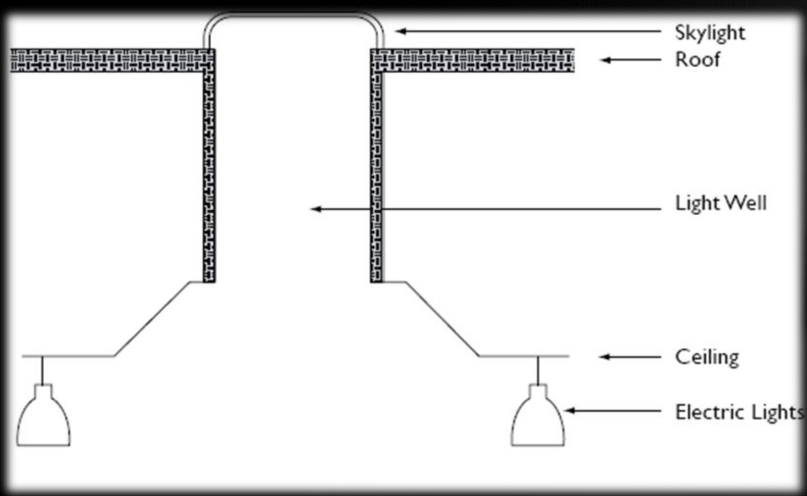
Daylight Harvesting Overview… benefits of daylight

- Numerous studies link daylight and views to higher levels of satisfaction and productivity
- Maximum 40% increase in sales in retail study
- Students with highest levels of daylight progressed 20-26% faster on math and reading tests in school study
- Office workers performed 10-25% better on tests and recall when they had the best possible view in office study

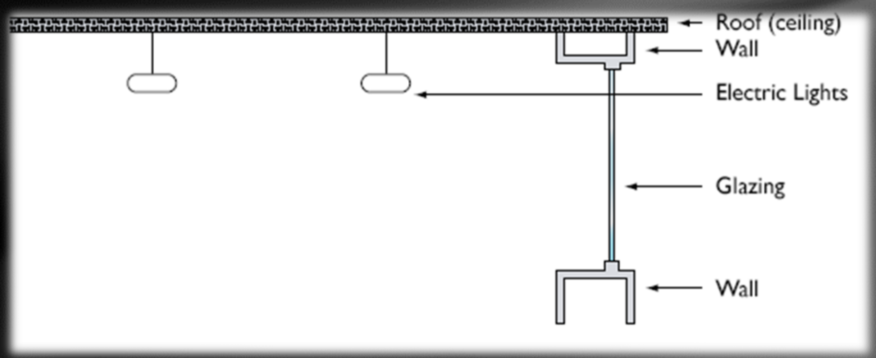
Above data supported by Heschong Mahone studies, 1999, 2003

Lighting Control Strategies

Daylight Harvesting Options… types of daylighting



Toplighting



Sidelighting

Lighting Control Strategies

Daylight Harvesting Energy Savings

Space Type	Lighting Energy Savings Demonstrated in Research or Estimated as Potential	Study Reference
Private Office (sidelighting)	50% (manual blinds) to 70% (optimally used manual blinds or automatic shading)	*Effect of Interior Design on the Daylight Availability in Open Plan Offices*, National Research Council of Canada, 2002.
Open Office (sidelighting)	40%	
Classroom (sidelighting)	50%	*Sidelighting Photocontrols Field Study*, Heschong Mahone Group, 2003.

Lighting Control Topologies

The Right Design for the Project

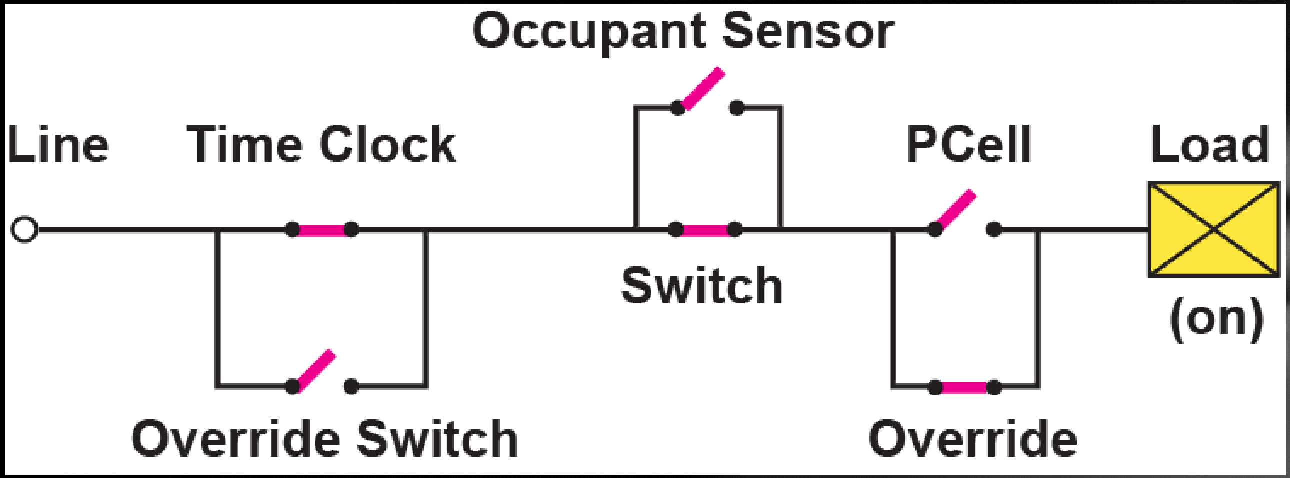
- Standalone

- Networked - Centralized

- Networked - Distributed

Lighting Control Topologies

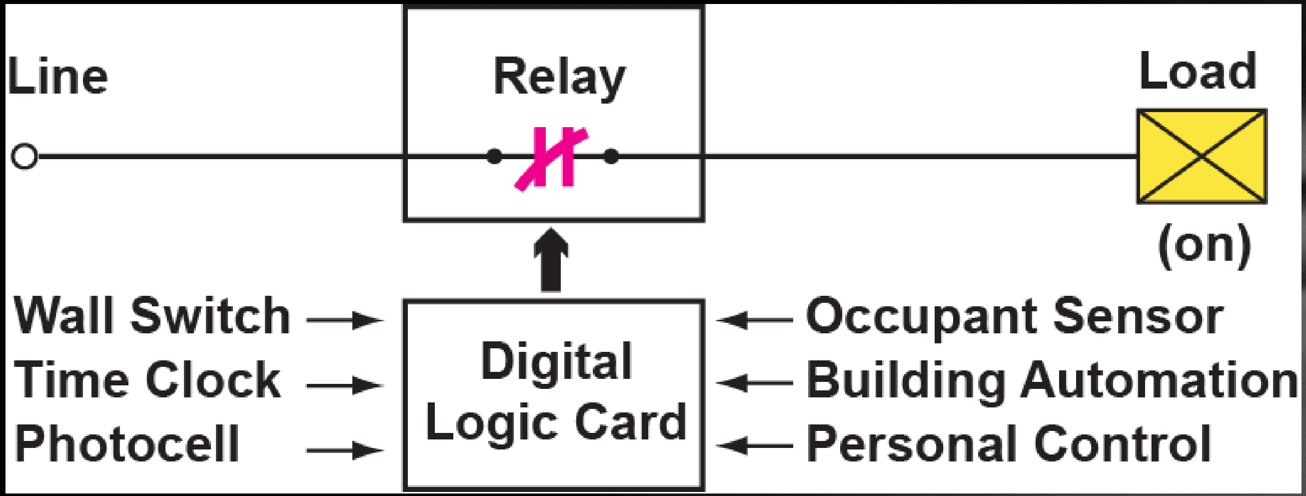
Standalone



- Code compliant design
- Least expensive component costs
- Complex wiring, increased labor time and costs
- Usability deficiencies, negative impact on occupants

Lighting Control Topologies

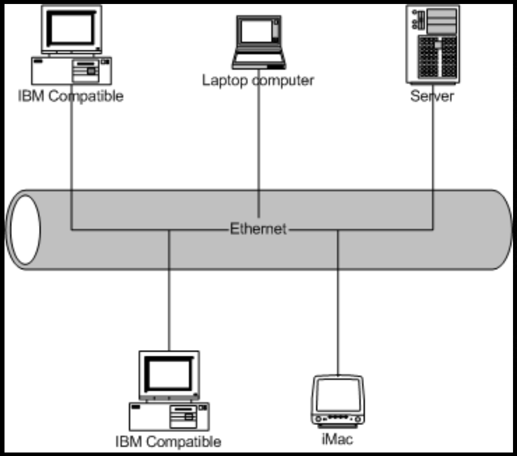
Networked - Centralized

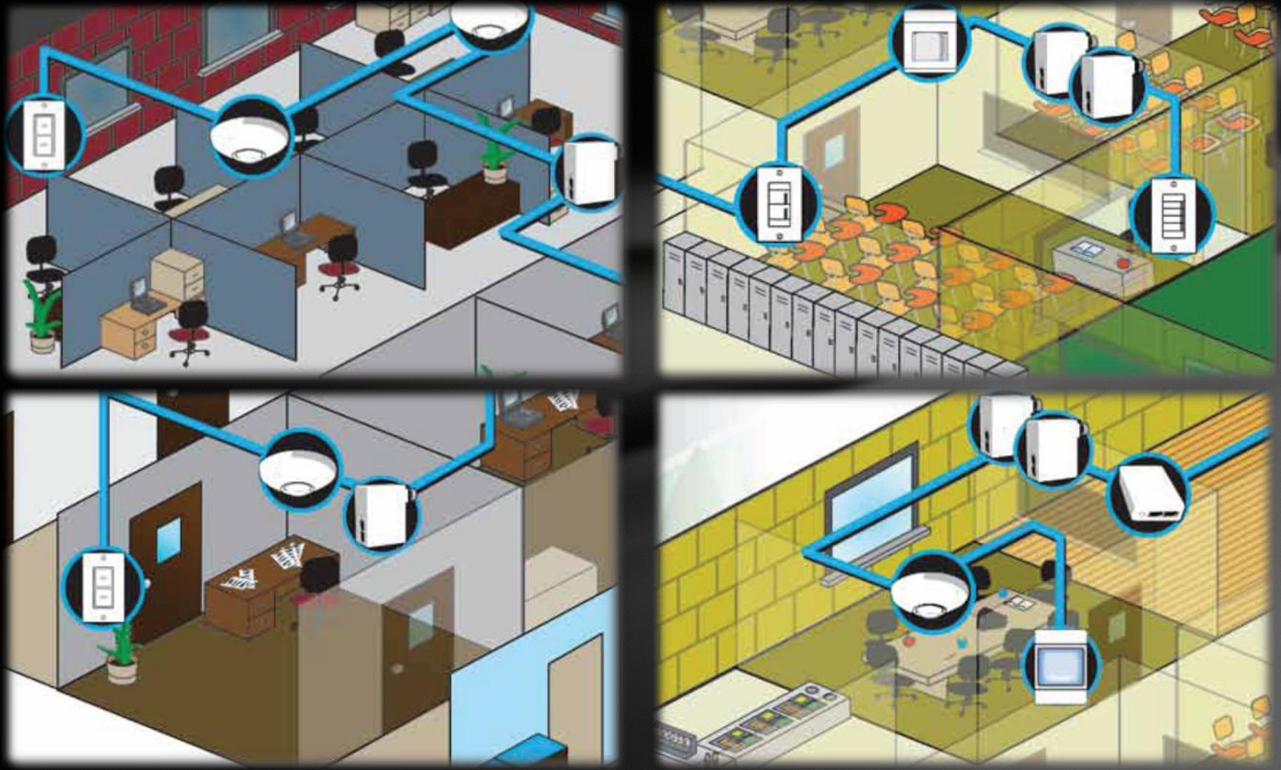


- Code compliant design
- Least expensive installed cost
- Centralized power and control wiring
- Logic card manages hierarchy of strategies resulting in effective energy management and occupant satisfaction

Lighting Control Topologies

Networked - Distributed





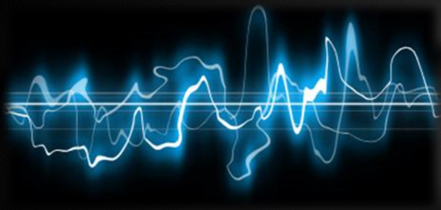
- Highest building performance and occupant satisfaction
- Independent power and control wiring yields flexibility
- Distributed architecture provides system redundancy

Sensor Selection and Placement

Occupancy Sensor Detection Methods

Passive Infrared

"I see you."



Ultrasonic

"I feel you."

Acoustic

"I hear you."

Sensor Selection and Placement

Occupancy Sensor Detection Methods

Passive infrared

Passive InfraRed (PIR) Technology

- Passive technology
- Sense difference in heat between moving people and background
- Requires line of sight
- Field of view can be adjusted
- Most sensitive to lateral motion (across sensor)
- Sensitivity to movement decreases with distance
- Avoid mounting near sources of heat

Sensor Selection and Placement

Occupancy Sensor Detection Methods

Ultrasonic

Ultrasonic Technology

- Active technology
- Emit ultrasonic sound waves and sense frequency changes in waves reflected back to the sensor
- Can "see" around obstacles
- Field of view cannot be adjusted
- Most sensitive to motion to and from sensor
- More sensitive than PIR to minor motion
- Avoid mounting near sources of air flow
- Can cause interference with new Smart White Boards
- Utilized in tandem with PIR – Active Dual Technology

Sensor Selection and Placement

Occupancy Sensor Detection Methods

Acoustic

Acoustic Technology

- Passive technology
- Microphone listens for sounds caused by typical motion
- Uses on-board intelligence to distinguish between white noise and human activity
- Does not interfere with ultrasonic building systems
- Utilized in tandem with PIR – Passive Dual Technology

Sensor Selection and Placement

Occupancy Sensor Detection Methods

Passive infrared

Ultrasonic

Active dual technology

- Combines ultrasonic and PIR technologies
- PIR must detect occupancy to turn lights ON
- Only one must detect occupancy to keep lights ON
- Recommended for applications requiring greater reliability than single technology

Sensor Selection and Placement

Occupancy Sensor Detection Methods

Passive infrared

Acoustic

Passive Dual Technology

- Acoustic technology is available, combined with Passive Infrared technology. The resultant combination is called Passive Dual Technology
- PIR must detect occupancy to turn lights ON
- Only one must detect occupancy to keep lights ON
    - Crosschecking algorithm – verifies relay state
- Not subject to false triggering from HVAC airflow like Ultrasonic technology
- Lower power consumption than active Ultrasonic dual technology
- Recommended for applications requiring greater reliability than single technology
- Eliminates risk of interference issues posed by Ultrasonic technology

Sensor Selection and Placement

Occupancy Sensor Detection Methods

Passive infrared

Ultrasonic

Acoustic

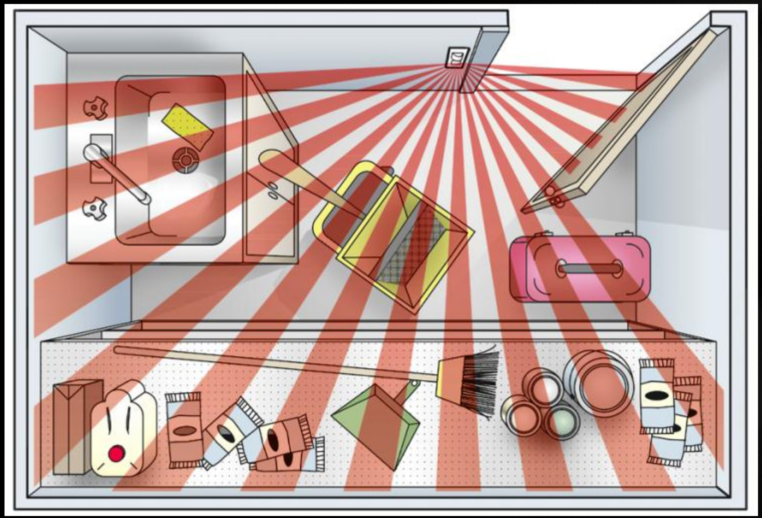
Sensor Placement Guidelines

- Sensor types are available as a wall switch, wall, ceiling, and as a high-bay light fixture add-on
- Sensor should detect occupancy immediately
- Sensor should not detect occupancy outside controlled spaces
- Position sensors above or close to the main areas of activity in a space
- View should not be obstructed by door swing
- Do not place within 6-8 ft. of a heat source such as an HVAC air diffuser.
- Do not use Ultrasonic Sensor near sources of vibration
- Ensure proper coverage pattern
- Acoustic detection facilitated by hard floors and lack of white noise

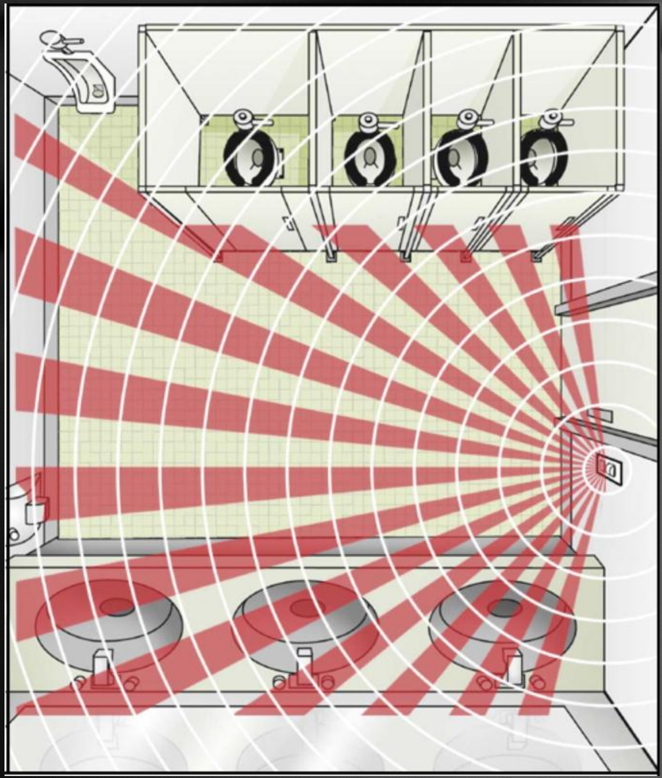
Sensor Selection and Placement

Wall-mount Occupancy Sensor Application Example

PIR wall-mount sensor: storage closet



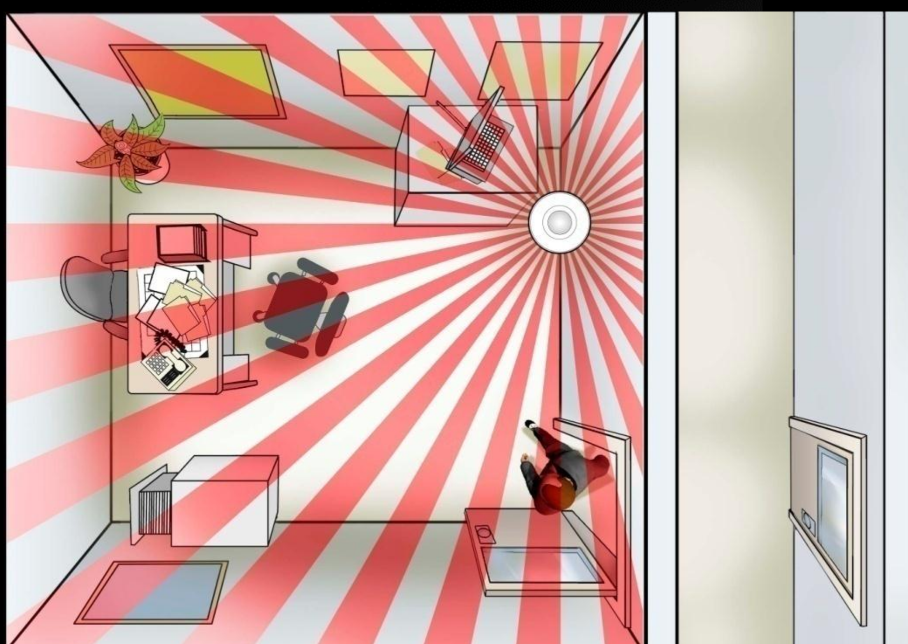
Dual-technology wall-mount sensor: small restroom



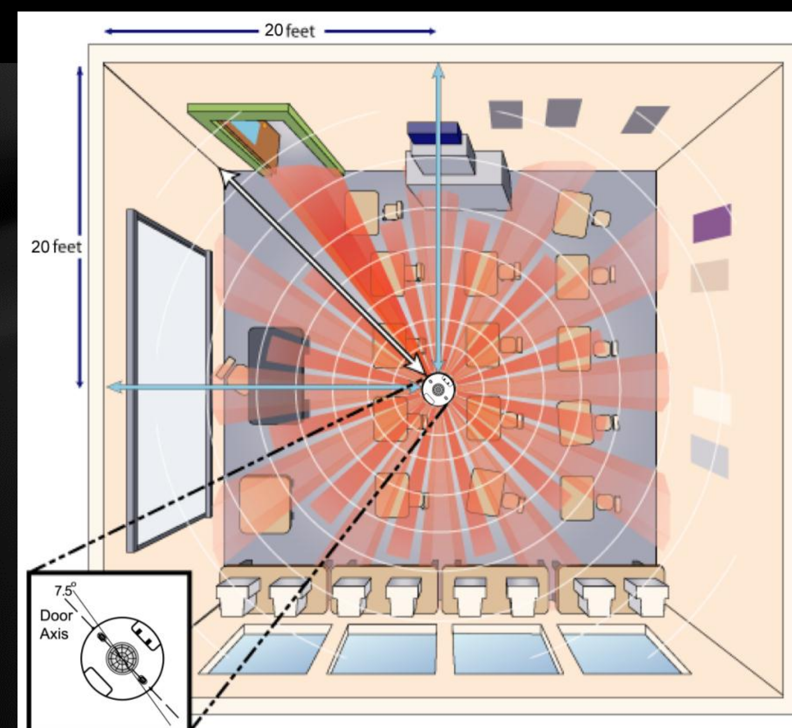
Sensor Selection and Placement

Ceiling-mount Occupancy Sensor Application Example

PIR ceiling-mount sensor: private office

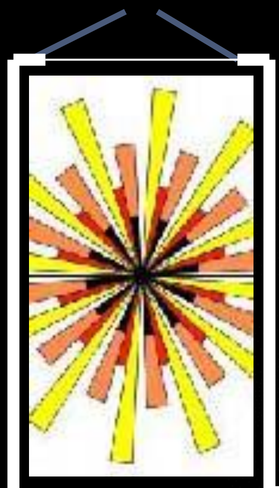


Dual-technology ceiling-mount sensor: classroom

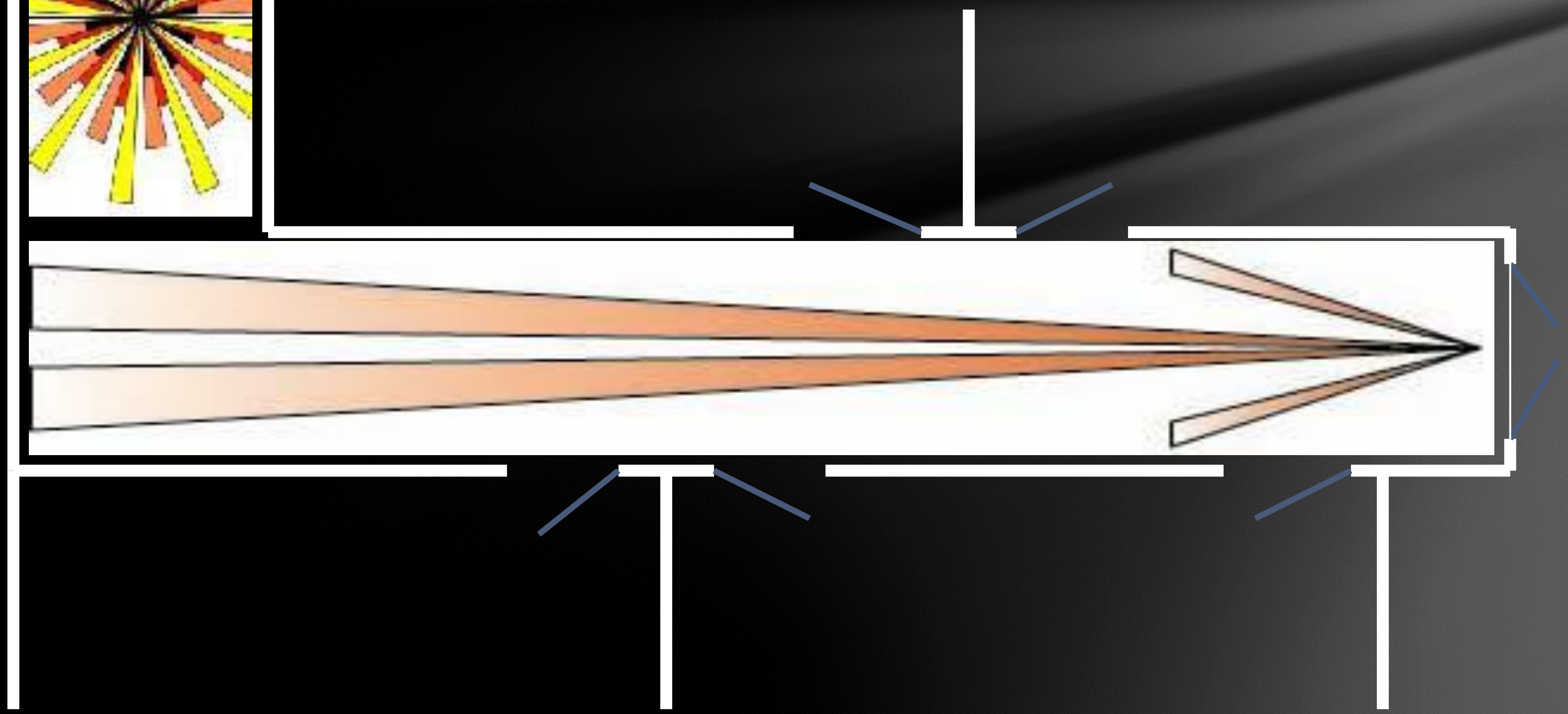


Sensor Selection and Placement

Narrow View Occupancy Sensor Application Example



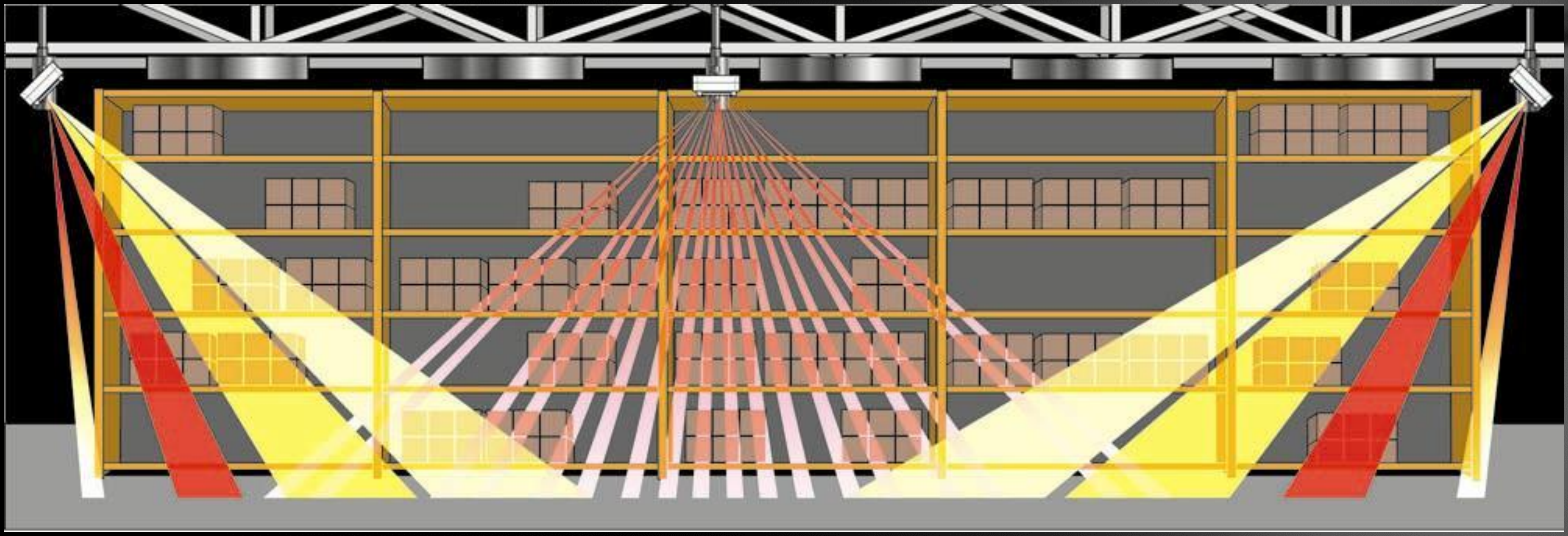
PIR narrow view sensor: hallway



Sensor Selection and Placement

High Bay Occupancy Sensor Application Example

PIR high bay sensor: warehouse aisle coverage



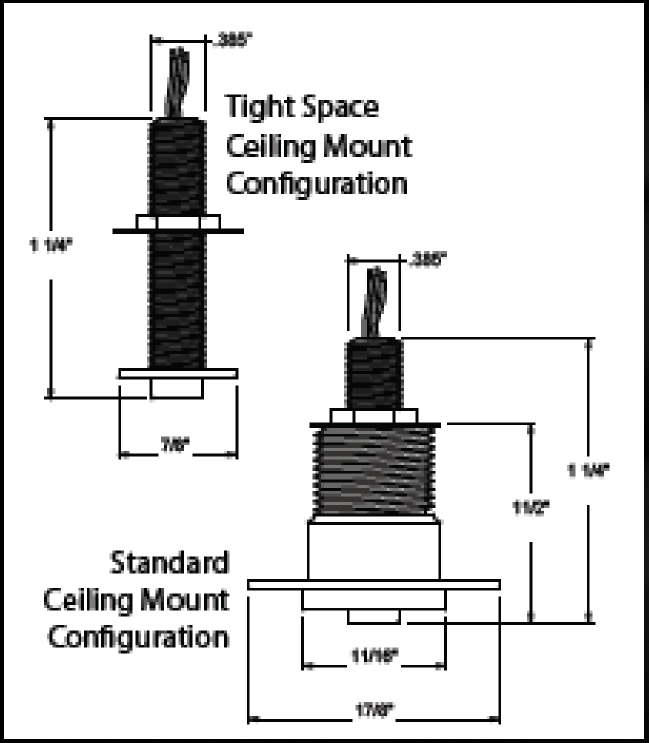
Sensor Selection and Placement

High Bay Occupancy Sensor Application Example

PIR high bay sensor: warehouse fixture coverage

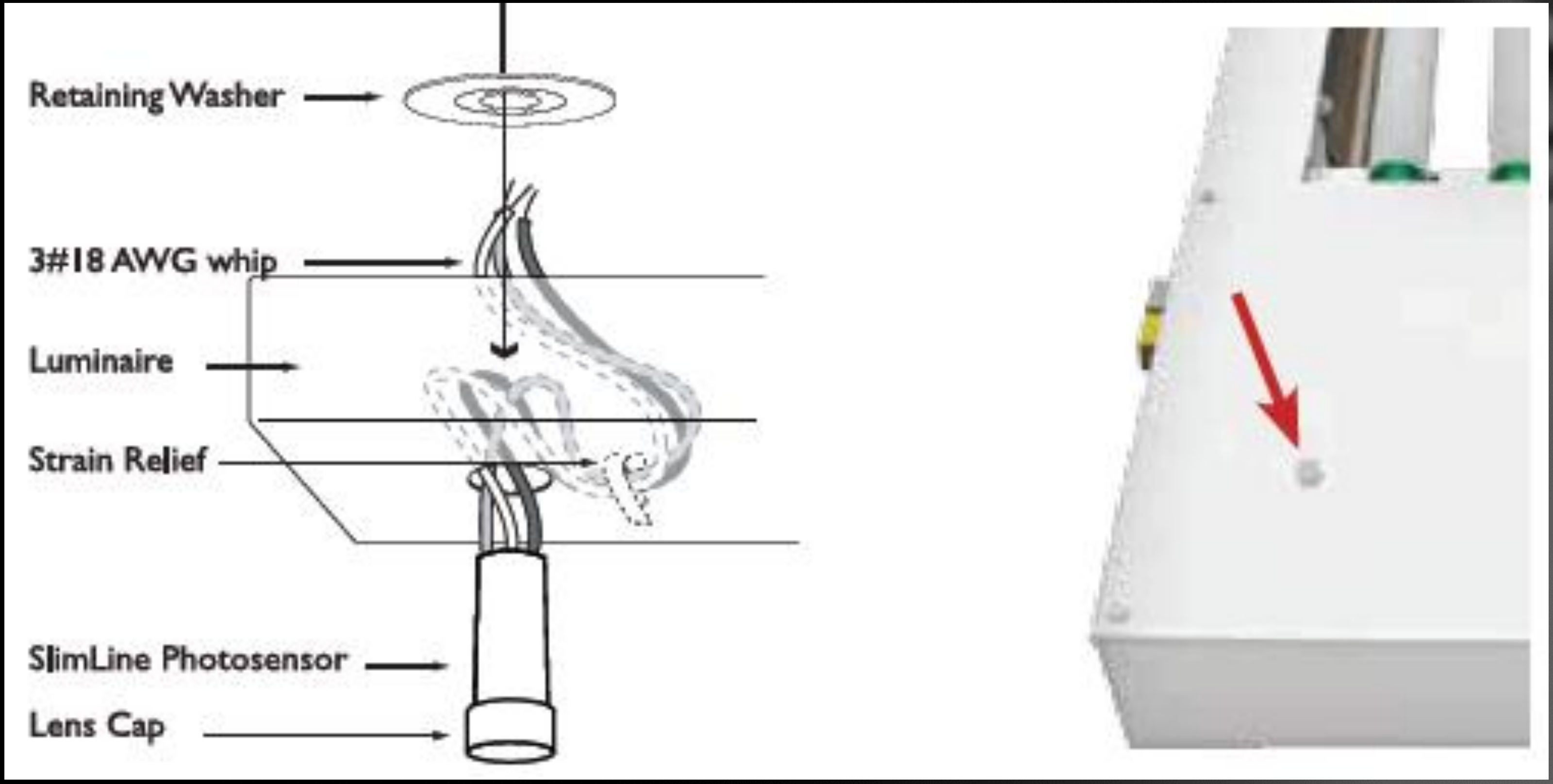
Sensor Selection and Placement

Standalone Photosensors (Analog) – ceiling mount



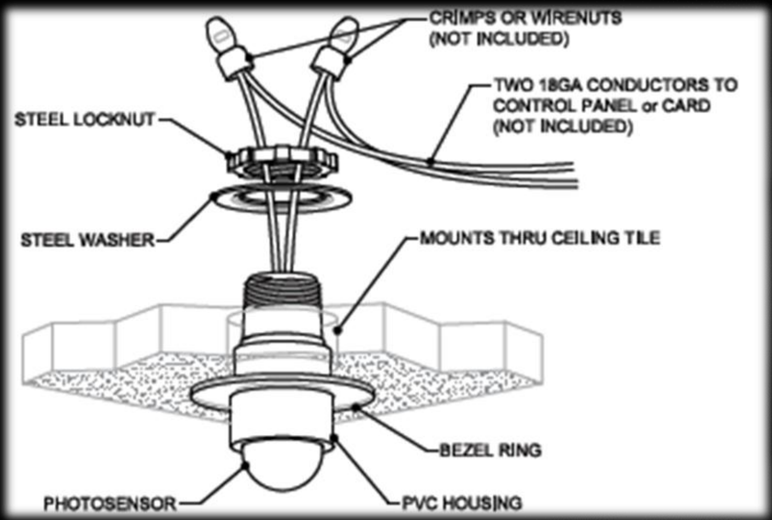
Sensor Selection and Placement

Standalone Photosensors – fixture mount

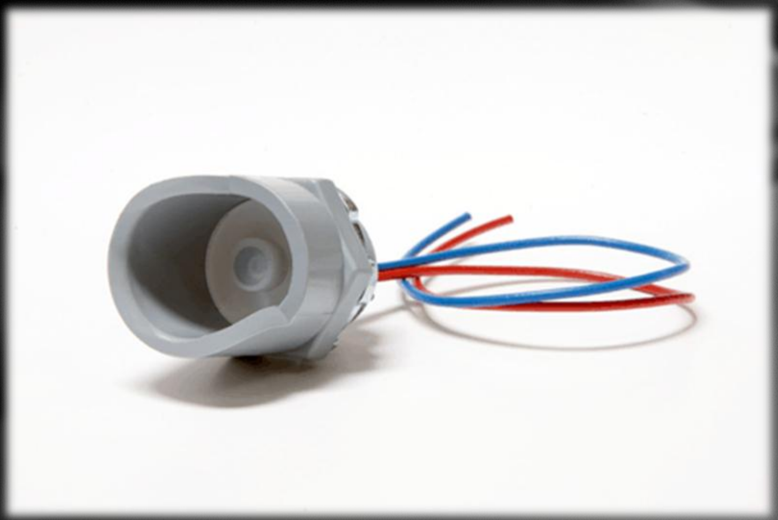


Sensor Selection and Placement

Networked Photosensors



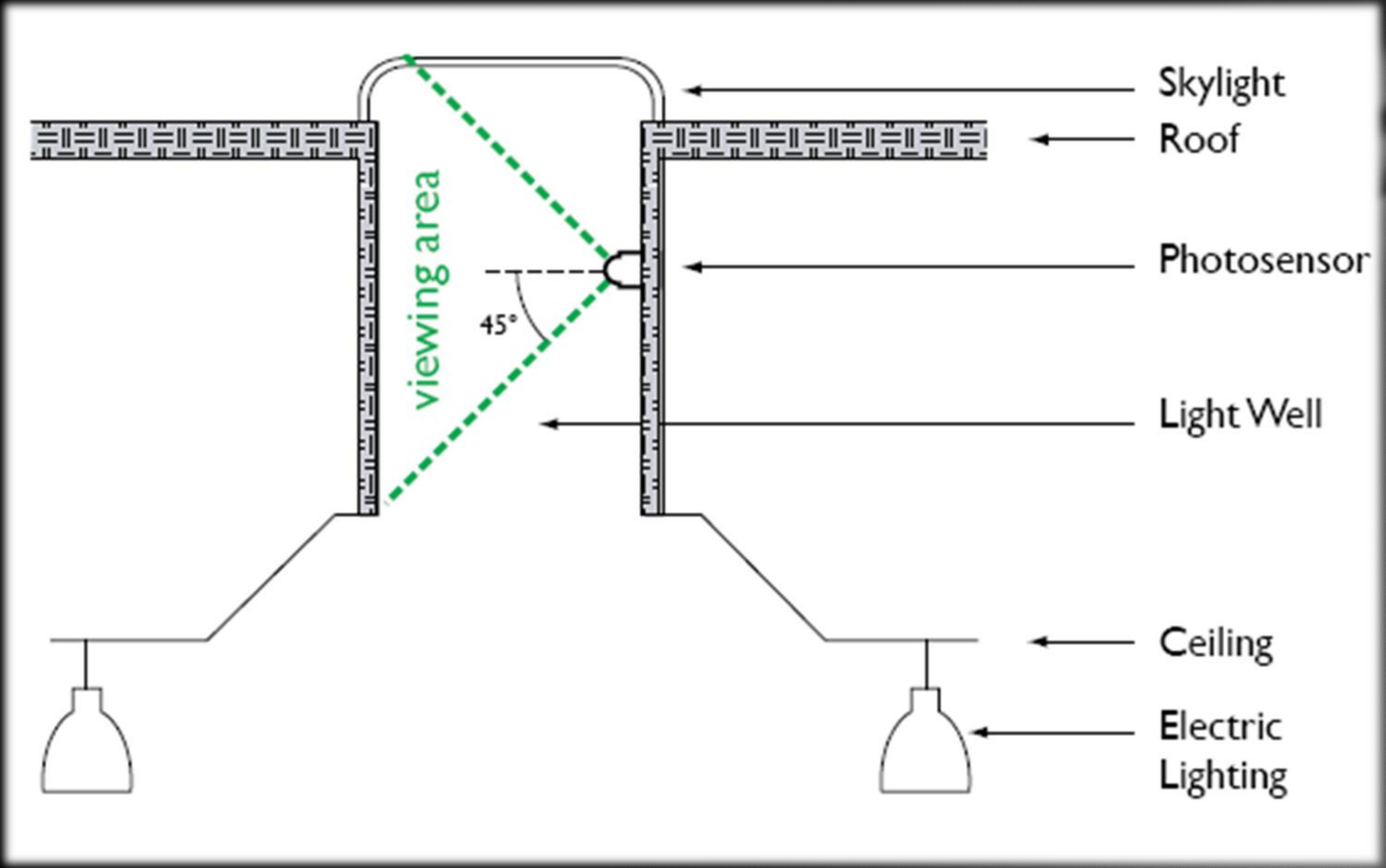
Indoor



Outdoor

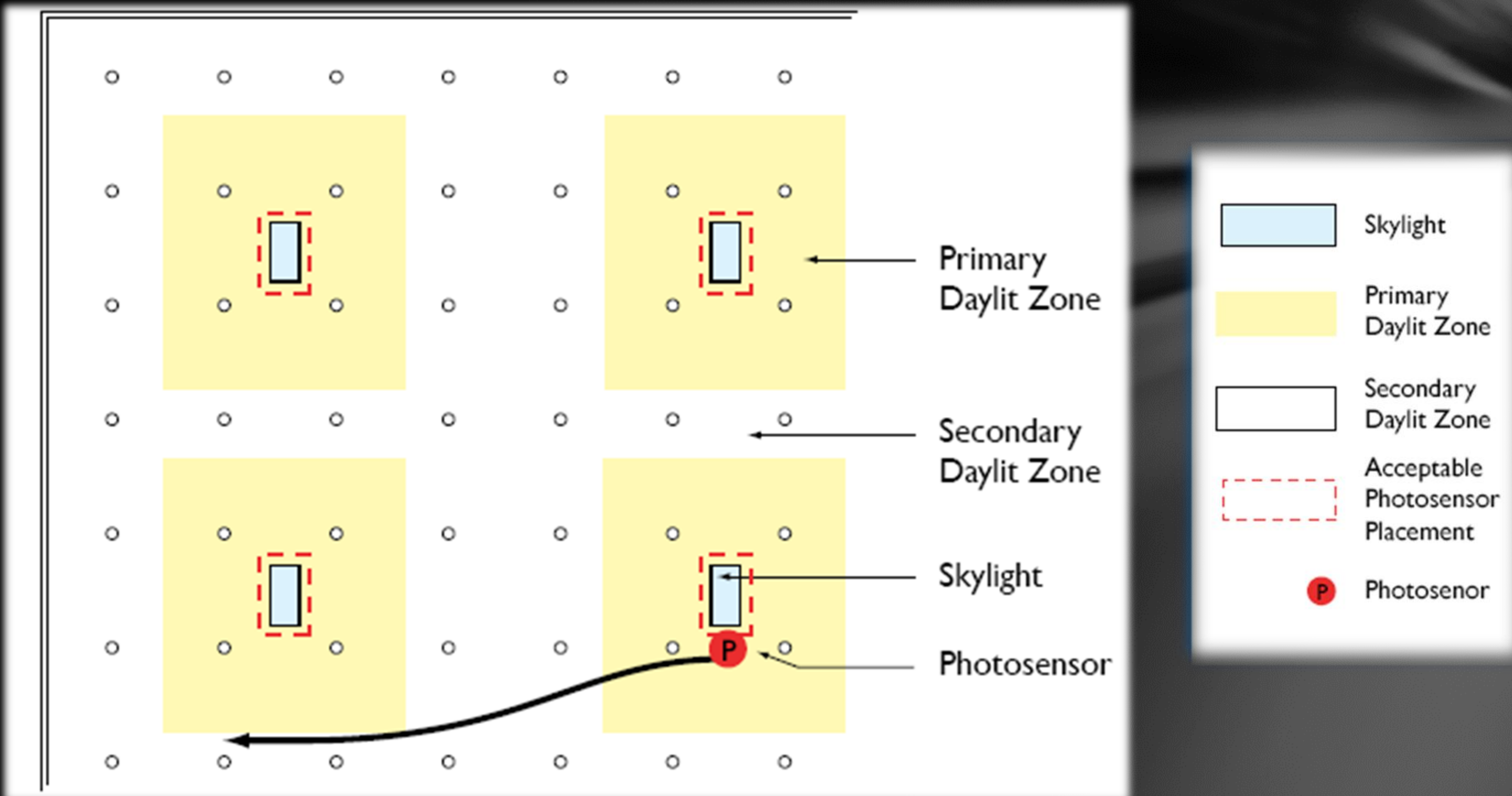
Sensor Selection and Placement

Photosensor Placement… open loop photosensors view daylight directly and do not respond to or “see” the electric light that it controls



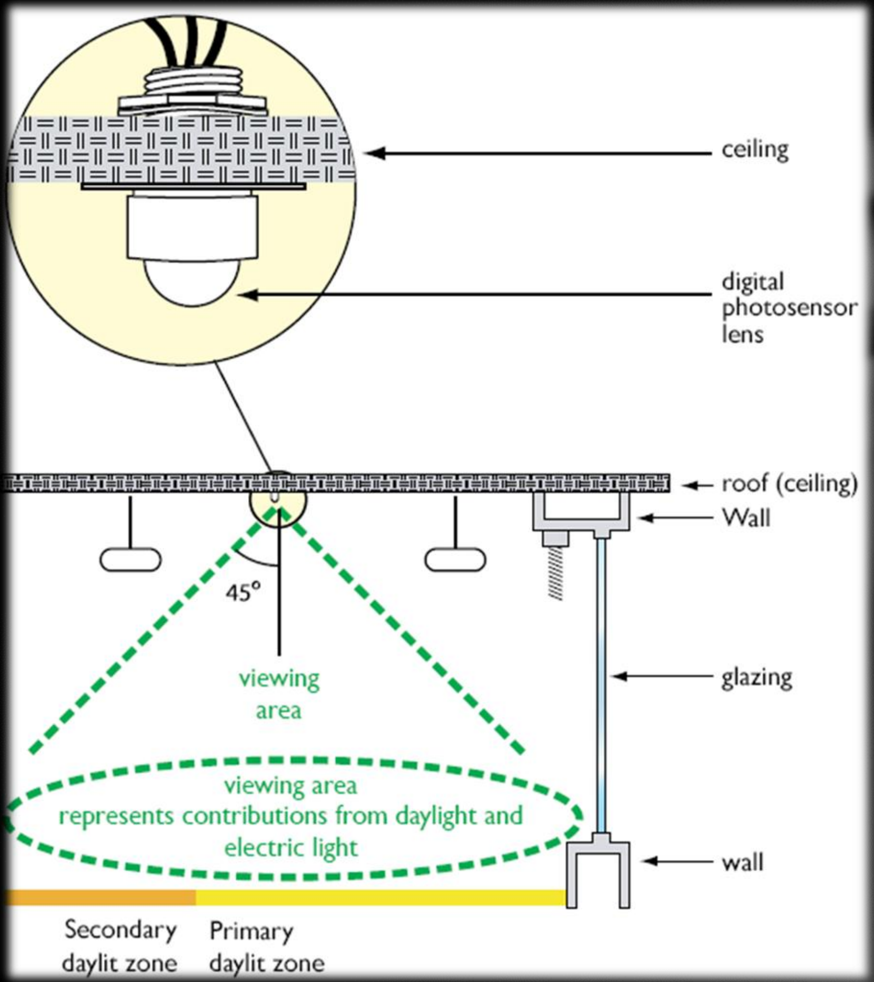
Sensor Selection and Placement

Photosensor Placement… Open loop – One sensor – Multiple control zones



Sensor Selection and Placement

Photosensor Placement… closed loop "sees" the results of the lighting being reduced



Commissioning and System Tuning

Design & Plan for Success

- Efficient and effective lighting control systems begin with proper design and planning
- Conceptualize sequence of operation of lighting control systems prior to installation… many systems can be partially or fully programmed by the manufacturer prior to delivery
- For larger systems or those with complex daylighting strategies, insist on factory commissioning

Commissioning and System Tuning

Occupancy Sensor Tips: Sensitivity + Time Delay

Sensitivity

- Field-adjustable setting on sensor that expresses how responsive sensor is to movement
  - Too high = false-ON triggering
  - Too low = false-OFF triggering
  - Changing sensitivity can change range and coverage pattern
  - Self-calibrating sensors require little or no adjustment of sensitivity

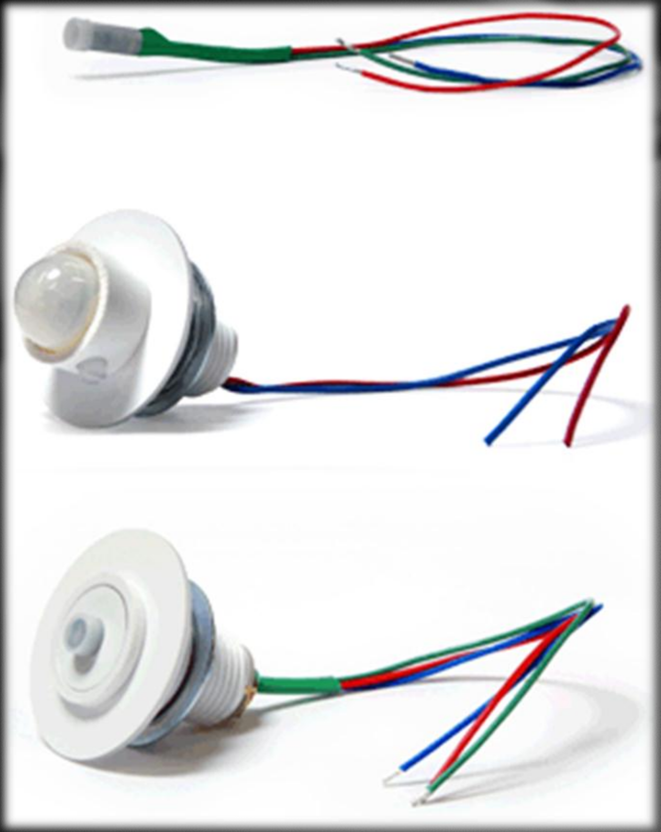
Time Delay

- Field-adjustable setting on sensor that determines the delay to off period
  - Too high = wasted energy
  - Too low = lamp damage
  - Self-calibrating technology maximizes energy savings and lamp life

Commissioning and System Tuning

Photosensor Tips: Technology & Compatibility

- Photosensor ease of set-up and operation is constantly improving
- Many photosensors, especially those designed to integrate with particular lighting control systems, are "plug and play"
- Automated shading enhances daylight harvesting
- <u>Use factory commissioning to maximize daylighting effectiveness</u>



Commissioning and System Tuning

My Worst Project

Pre-project Communication & Post-project Occupant Education

FAIL FAIL

Commissioning and System Tuning

Whirlpool *West Coast Distribution Center*

Stats:

1.9 million ft^2

Lighting power density:
.8 watts / sq ft

Skylights:
3% roof sq ft
(100% day lit)

25 – 32 ft ceilings

Commissioning and System Tuning

Whirlpool *West Coast Distribution Center*

Equipment:

6 lamp (3 ballast) T5HO High Bay Luminaires

Aisle Controls using occupancy sensors & photo sensors

Automatic On with Daylight Harvesting

Automatic Off (10 minute time delay)

Commissioning and System Tuning

Whirlpool *West Coast Distribution Center*

Initial Strategy:

Aisle Controls

Automatic On with Daylight Harvesting

Automatic Off (10 minute time delay)

Initial Cost Reduction: $31,800 per month

Commissioning and System Tuning

Whirlpool *West Coast Distribution Center*

Adjusted Strategy:

Aisle Controls

Automatic On with
Daylight Harvesting

Automatic Off
(7 minute time delay)

Modified Cost Reduction:
$35,700 per month

(additional savings of
$4,000/month)

Commissioning and System Tuning

Whirlpool *West Coast Distribution Center*

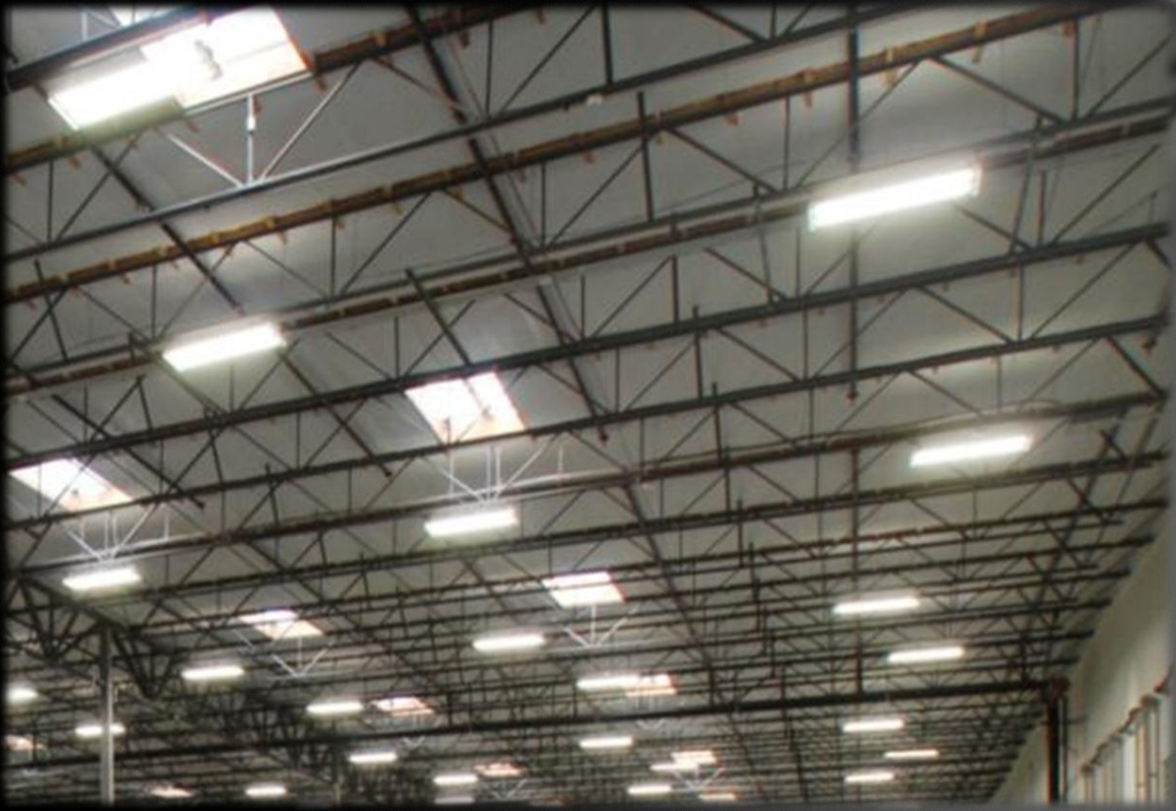
System Cost:

$170K

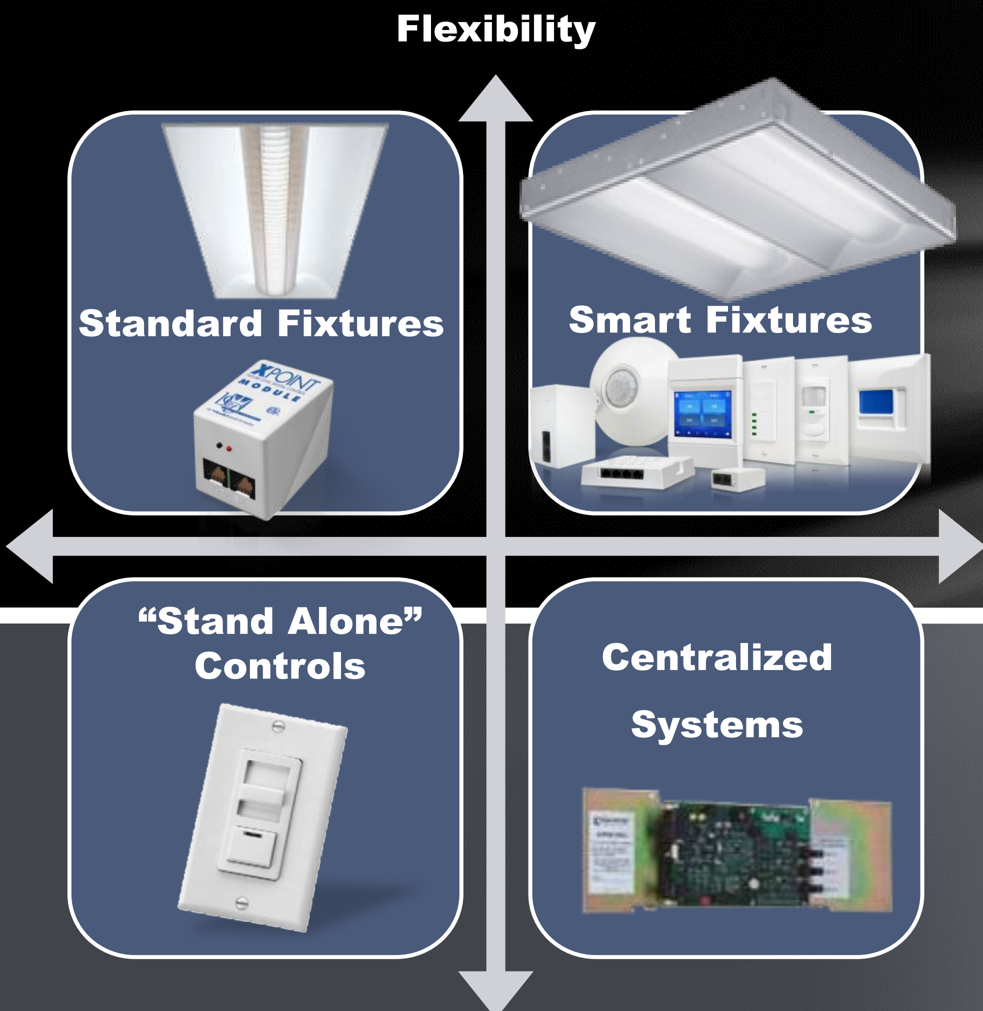
Payback:

Under 6 months

WIN!



Where are we headed?

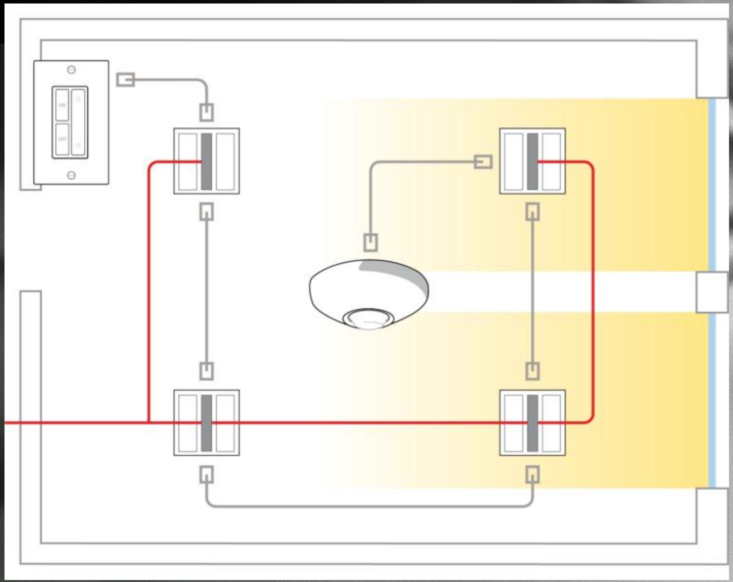


Control ON Board

Integrated Lighting & Controls

Control OFF Board

Where are we headed?



What are the design considerations?

- Code compliance
- Energy savings
- Building performance and flexibility
- Functionality of space
- Measurement/verification of investment

What are the benefits of an integrated solution?

- Meets advancing code requirements
- Saves energy
- Improves operational efficiency and building flexibility
- Enhances occupant comfort and productivity
- Achieves sustainable design initiatives and communicates savings

Summary

Manual control, scheduling, occupancy sensing, and daylight harvesting are the primary lighting control strategies

Combining lighting control strategies increases energy savings, building performance, occupant productivity, and sustainable design goals

Networked lighting control systems simplify system design, specification, and support

Thoughtful design, specification, installation, and commissioning of lighting control systems maximize building performance and occupant satisfaction

Industry trends are leaning more and more towards distributed control solutions and “intelligent” fixtures with integrated controls.

Questions?

Why Lighting Controls?

Thank You